AMATEUR SATELLITE REPORT

Number 130
August 18, 1986

Editor: Vern Riportella, WA2LQQ
Contr. Editors:
Eric Rosenberg, WA6YBT
Pete Killingsworth, KD7WZ
Paul Roemer, KG6LC
Managing Editor: Bob Myers, W1XT

AMSAT's Newsletter for the Amateur Radio Space Program

Amateur Satellite Report is endorsed by the American Radio Relay League as the special interest Newsletter serving the Amateur Radio Satellite Community

Copyright 1986 by *Amateur Satellite Report*

JAS-1 Launch Now 12 August

The launch of JAS-1, the Japanese Amateur Radio League (JARL) satellite, is currently scheduled for Tuesday, 12 August at 2030 UTC. AMSAT is supporting the launch with ALINS, the AMSAT Launch Information Net Service.

According to VP/Operations Ralph Wallio, WØRPK, the realtime launch coverage begins on launch day, 12 August (U.S. time). Coverage will start with hf net check-ins at 1930 UTC. Teleconference linking of all net stations will begin at 2000 UTC. Nets will be active on 40, 20 and (conditions permitting) 15 meters as follows:

7185 KHz	WA3NAN WØRPK TBD	Greenbelt, MD Des Moines, IA	Eastcoast Midwest Westcoast
14282	WA2LQQ W6SP	Warwick, NY Los Angeles, CA	Europe South Pacific
14295	WA3NAN	Greenbelt, MD	USA
21390	WA3NAN	Greenbelt, MD	S. America (propagation permitting)

A first-hand description of launch and boost phases will be provided by JA1ANG from Japan.

Teleconference and net operations will continue during JAS-1 separation and first beacon reports from Eduardo Diaz, CE3GA, in Santiago, Chile at approximately 2130 UTC. These reports and a wrap-up of events will conclude the realtime coverage at 2200 UTC.

ALINS will provide post-launch advisories sent from Tokyo on Wednesday, Thursday and Friday, 13 - 15 August, as necessary. Besides the regular 75 meter Tuesday net session, special 75 meter AMSAT net sessions will be held on Wednesday, Thursday and Friday evenings at the usual times to distribute Keplerian elements, satellite information and to recap launch coverage.

The following set of pre-launch Keplerian elements has been adjusted to the currently planned separation time which assumes a nominal lift-off time:

Ref Epoch:	86 224.897306 UTC
Inclination:	50.004 deg
RAAN:	249.2755 deg
Eccentricity:	0.0001407
Arg. of Per:	2.155 deg
Mean Anomaly:	330.246 deg
Mean Motion:	12.412719 rev/day
Decay:	0 rev/day/day
Epoch Rev:	0
SMA	7879.56 km
Beacon:	435.795 MHz

JAS-1 Operating Frequencies

Mode JA uplink: 145.900 to 146.000 MHz
Mode JA downlink: 435.900 to 435.800 MHz.
(Inverting transponder)

Operating frequencies for Mode JA, the Mode J analog mode for SSB and CW, may be determined as follows. The sum of the uplink and downlink frequencies equals 581.800 MHz exclusive of Doppler shift. For example, if the uplink is 145.920 MHz, the downlink will be 435.880 MHz. Conversely, if you want the downlink to be 435.810 MHz, you should set your uplink for 145.990 MHz. In both these examples, the sum of the uplink and downlink equals 581.800 MHz.

See the frequency correlation table.

The beacon will be 435.795 MHz. When first activated at separation the beacon will be sending 20 wpm cw telemetry. (See related telemetry story)

Mode JD, the digital Mode J, will be activated later this autumn.

Frequency Correlation Table

Uplink	Downlink
145.900 MHz	435.900 MHz
145.910	435.890
145.920	435.880
145.930	435.870
145.940	435.860
145.950	435.850
145.960	435.840
145.970	435.830
145.980	435.820
145.990	435.810
146.000	435.800

JAS-1 Telemetry Format Delineated

JAS-1 telemetry transmission will commence immediately upon separation about one hour after launch. The beacon will be heard on 435.795 MHz exclusive of Doppler shift. The telemetry will be sent on Mode JA using 20 wpm CW.

The format of the the telemetry will be as shown in Table 1. The characters will be sent as three digit numbers in standard Morse. Telemetry sends two types of information:

1) Numerical data relating to operating conditions such as temperature
2) Status points such as beacon in PSK or CW

There are 30 data items and 33 status points monitored. However, the beacon transmits only 12 of the data items while transmitting all 33 status points.

Data items are contained in cells 1A through 3D in Table 1. In each of these 12 telemetry cells, each data word is a three digit number, e.g. 175, where 1 is the row number and 75 is the data content. To convert the telemetered value to engineering units, first ignore the most significant (left-most) digit. Then divide the remaining two-digit number by 50 to obtain "N". Then plug "N" into the equation shown in Table 2. For example, if 175 was sent in the 1D cell, the value is calculated as follows: 175 discarding the 1 (row number) becomes 75. Then 75/50 = 1.5 = N. And from Table 2, for 1D, N * 4.92 = 7.38 volts.

Status points are coded in telemetry cells 4A through 5D. As before, each cell is sent as a three character decimal number. To convert to status point information, discard the row number (first character in each trio sent) Then take the remaining two digit number and convert it to a three bit binary number as in Table 3. For example, decimal 423 is sent as cell 4A. Discard the row identifier "4" leaving 23. Convert 2 and 3 to binary: 010 and 011. Then butt these two strings together thus: 010011. Next, discard the left-most bit to yield 10011. This five-bit number denotes the status of the first five status points as shown in Table 4. The left-most bit is status point 5; then next is status point 4, etc. Thus, for this example, 423 converts to 10011 which means:

Point 5 1 = PSK on {Left-most bit}
Point 4 0 = (not used)
Point 3 0 = (not used)
Point 2 1 = JTD on
Point 1 1 = JTA on {Right-most bit}

Similarly, cell 4B codes status points 6 through 10; 4C codes 11 through 15; etc.

Table 1. Telemetry Format

	HI HI	1A	1B	1C	1D	Row 1
One complete frame		2A	2B	2C	2D	Row 2
		3A	3B	3C	3D	Row 3
		4A	4B	4C	4D	Row 4
		5A	5B	5C	5D	Row 5
	Column	A	B	C	D	

Order of transmission is a raster scan, i.e., row 1, A through D; then row 2, row 3, row 4. Except for the "HI HI" frame sync, the telemetry is formed in a 4 by 4 matrix comprising 16 cells. For example, 3C is a cell.

Table 2. Conversion of Analog Telemetry

Cell	Item	Range	Units	Equation
1A	Current from solar cells	0 to 2	Amps	I = N
1B	Battery charge/discharge	−2 to +2	Amps	I = −(1−N) * 2
1C	Battery terminal voltage	0 to 20	volts	V = N * 11
1D	Battery center tap	0 to 10	volts	V = N * 4.92
2A	Bus voltage	0 to 20	volts	V = N * 10.08
2B	Regulated +5 volt line	0 to 7.5	volts	V = N * 3.004
2C	Mode JA power out	0 to 3	watts	$P = N^{1.618} * 1.101$
2D	Calibration voltage	0 to 2	volts	V = N
3A	Battery cell temperature	−50 to +70	deg C	T = (1.3−N) * 73
3B	Bus structure 1 temperature	−50 to +70	deg C	T = (1.3−N) * 73
3C	Bus structure 2 temperature	−50 to +70	deg C	T = (1.3−N) * 73
3D	Bus structure 3 temperature	−50 to +70	deg C	T = (1.3−N) * 73

Table 3. Decimal To Binary Conversion

Decimal Value	Equivalent Binary Value
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

Table 4. System Status Points

Cell	Status Point	Item
4A	1	JTA on/off
4A	2	JTD on/off
4A	3	(Not used)
4A	4	(Blank)
4A	5	Beacon PSK on/off
4B	6	UVC on/off
4B	7	UVC level 1/2
4B	8	Battery full/trickle
4B	9	Battery logic, full/trickle
4B	10	Main relay on/off
4C	11	PCU level-I
4C	12	PCU level-II
4C	13	PCU manual/auto
4C	14	Command priority
4C	15	Command select
4D	16	Memory 0 on/off
4D	17	Memory 1 on/off
4D	18	Memory 2 on/off
4D	19	Memory 3 on/off
4D	20	CPU on/off
5A	21	MSEL 0
5A	22	MSEL 1
5A	23	IPL SEL 0
5A	24	IPL SEL 1
5A	25	CRC MOD
5B	26	Sun/shade sense 1
5B	27	Sun/shade sense 2
5B	28	Sun/shade sense 3
5B	29	Sun/shade sense 4
5B	30	Sun/shade sense 5
5C	31	CW CPU/tlm
5C	32	CPU reset
5C	33	CW tlm

[Balance presumed blank-Ed.]

AO-10 Returns To Service

After two months off the air due to a serious computer malfunction, AMSAT OSCAR 10 has been returned to service. After two weeks back on line, transponder use has returned to near-normal levels. Users reported excellent

conditions on both Mode B and Mode L. This was probably attributable to the orientation of the satellite which was nearly ideal at Bahn longitude 184 and latitude -2 degrees. This close to optimum since at 180 and 0 degrees, the satellite's antennas point directly to the earth's center at apogee.

The current operating schedule is:

Mode B	MA 075 thru 119
Mode L	MA 120 thru 136
Mode B	MA 137 thru 180
Off	MA 181 thru 074

Eclipses in early August are occurring on each orbit near MA 32 and lasting up to approximately 50 minutes. With the end of the current cycle of eclipses later in August, it may be possible to expand the operating schedule if user power demands moderate.

With the return of transponder operations, it may be well to review good operating practice. Users should carefully control their uplink power to assure their downlink is comparable to the beacon. In fact, being told that ones signal is very strong, could likely be construed as an insult by a seasoned AO-10 operator! As a general guide, AMSAT advises that if you can't hear the beacon well, you need to work on your receive system. And if you can't hear the beacon at all, you need to QRT until you make needed repairs.

The overall satellite condition is stable and, for all external appearances, things have returned to normal. However, ZL1AOX and DJ4ZC continue to work behind the scenes to maintain the radiation-damaged IHU memory. No one familiar with the circumstances believes we have seen the last of the problems which crashed the IHU on May 17th. Rather, most hope AO-10's useful life can be extended until Phase 3C is on station in mid-1987. To accomplish this end, controllers continue to juggle available memory resources in the face of a dynamic situation in the IHU.

Users can aid this effort by observing recommended power levels to avoid unduly draining the batteries.

25th Anniversary Operating Event Previewed

Do YOU remember what major event occurred in Amateur Radio in 1961? Although it hardly seems possible it's true! OSCAR will soon be 25 years old.

One of the most important turning points in Amateur Radio was when, on December 12, 1961, the ten pound OSCAR 1 package was launched into space and into history.

To commemorate OSCAR's 25th birthday, AMSAT is sponsoring a month long party!

During the entire month of December, veteran and new OSCAR operators alike will be encouraged to polish their OSCAR stations and operating skills to contact as many others as possible using the available satellite transponders.

During the event this December, AMSAT encourages all OSCAR operators to include in their QSOs:

(1) Details of their past OSCAR operations including the birds and transponders they have heard or communicated through.

(2) Their international satellite organizational affiliation(s) and, if applicable, their membership number(s).

The top ten station scores will be recognized with a unique, engraved OSCAR 25th Anniversary Operating Event plaque. All stations submitting logs and score sheets will receive an OSCAR 25th Anniversary Operating Event Certificate. Operating event details, rules and sample log sheets will be available soon. Watch for announcements from the AMSAT News Service.

New Area Coordinators Named

AMSAT's Chief Area Coordinator Mike Crisler, N4IFD, announces the following Assistant Area Coordinator appointments:

Terry Surface,	N4IQV,	Sugar Grove, VA
Marvin Solomon,	KI4EA,	Ashville, NC
Gary Hoffman,	KE4ZV,	Lawrenceville, GA
Bradley Pioveson,	WA9KNP,	Benton, IL
Pete Killingsworth,	KD7WZ,	Spokane, W
David Smith,	WA6YDI,	Fresno, CA
Ken Wilhoit, Jr,	W4OCW,	Marietta, GA
Paul Haasis,	N1DBB,	Billerica, MA
Randy Baker,	WA2EXJ,	Madison, NY
Harold Bulmahn,	W5DSG,	Waco, TX
Ed Kucbel,	VE3KRP,	Thunder Bay, Ontario
R.G. Maniago,	KA5RMT,	Vernon, TX

AMSAT congratulates the new appointees!

Short Bursts

• The AMSAT Directors nomination period closed July 31. According to Administrative Director Martha Saragovitz, the following were nominated: WØRPK, KE3D, WA5ZIB, K8OCL, WBØRLY and the three incumbents W3IWI, JA1ANG and WA2LQQ. Ballots will be sent to all members of record by month's end.

• The *Satellite Experimenter's Handbook* recently exceeded sales of 20,000 copies. Written by Martin Davidoff, K2UBC, for ARRL, the text is generally acknowledged to be the best single source of Amateur Satellite information. Marty had added a special provision to his contract with ARRL which provides a modest royalty be paid to AMSAT after 20,000 copies were sold. ARRL has notified AMSAT this provision has recently been triggered by the sales milestone. Congratulations to K2UBC and ARRL for this achievement.

• Paul Roemer, KG6LC, New Hampshire Area Coordinator, reports that comments have been received from the volunteer "Beta" test team shaking-down Paul's ORBITS tracking program for the Commodore 128. Paul says the program is now being updated to include some of the suggested improvements. The revised disks and documentation will be distributed in the next few weeks. Paul adds his thanks to all who helped in this effort.

• AMSAT now has a new catalog of premiums available. The catalog presents AMSAT software, the new caps, AMSAT tie tacks, the very handsome 25th Anniversary patch and more. A complete catalog is available from AMSAT for a business-sized SASE to: AMSAT, P.O. Box 27, Washington, D.C., 20044.

• The Phase 3C satellite has arrived in West Germany for further work in preparation for its planned 1987 launch. The spacecraft was integrated and tested in Colorado and shipped recently. Additional work will now proceed under the auspices of AMSAT DL, partners with AMSAT North America in the Phase 3C project.

• Arianespace has told AMSAT that the problems which caused the recent loss of the V-18 mission 30 May will delay the next launch, V-19 until first quarter 1987. The problem is a complex one associated with the problem-plagued HM7B third stage cryogenic engine built be S.E.P. of France. This means AMSAT's Phase 3C aboard the V-21 mission will likely be launched mid-summer, 1987, based on current estimates.

Calculating SMA

A Mini-Tutorial by Phil Karn, KA9Q

I've noticed some satellite tracking software depends on the semi-major-axis values provided in the AMSAT orbital element bulletins. (I found this out only after having shut my system down during my week's sojourn in England...when things work okay, you hear not a whisper!)

In Keplerian two-body motion, if you know the mean motion and the mass of the planet, you know the semi-major axis, and vice versa. My algorithm is more complicated than that because the earth isn't quite spherical — the calculation is also affected by the eccentricity and inclination of the orbit. I compute an initial approximation and then iterate using an SMA-to-mean-motion formula to find the actual value. (There's an analytical solution, i.e., without iteration, but it's very complex involving a truncated infinite series).

The initial guess isn't really that far off, so users can use it to compute their own SMA values. The formula I use is:

$a = (XKE/n)^{2/3}$, where:
a= semi-major axis (earth radii)
n= mean motion, radians/day (= 2*pi*rev/day)
XKE= gravitational constant for the earth
= 107.08816103641419405 $(e.r.^{3/2})$/day

Notice the units of XKE are earth radii to the 3/2 power per day. Satellite tracking programs operate internally in terms of "canonical units"; instead of kilometers, distances are measured in terms of "earth radii" (6378.145 km). Note also that mean motion is in radians/day, not revolutions/day. So in conventional units

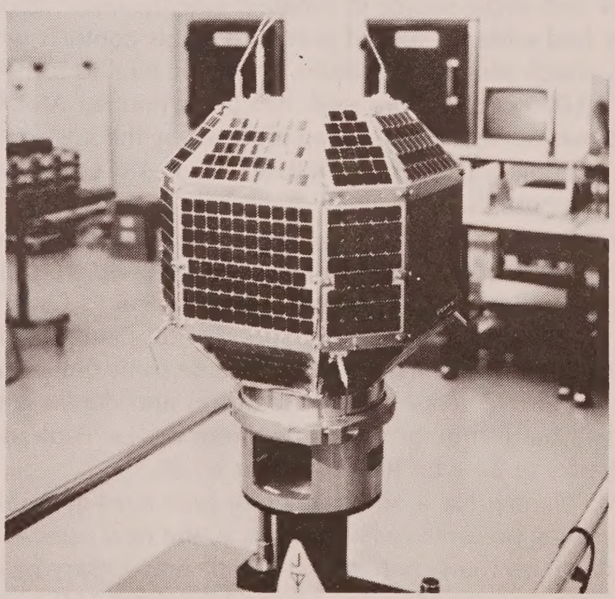
$a = 6378.145 * (XKE/(2*pi*n))^{2/3}$

where XKE is the same as before (107.088...), n is now in rev/day, and "a" is in kilometers. Finally, this simplifies to:

$a = (8681668.016/n)^{2/3}$

By the way, the reason NASA prediction bulletins give mean motion instead of semi major axis is because an error in computing mean motion from SMA is much more serious — it shows up as a steady, cumulative error in mean anomaly, i.e., orbit position. An error in computing SMA from mean motion is much less of a problem; it shows up as a consistent (i.e., non cumulative) error of a few km in predicted slant range, which is significant only when doing orbital determination based on range measurements. For ordinary tracking applications this is not a problem.

The Radio Amateur Satellite Corporation
Post Office Box 27
Washington, DC 20044



Japanese Amateur Radio League satellite JAS-1.

**Non-Profit
Organization
Second Class
POSTAGE PAID
at
Waterbury, Conn.**

LM-1096 KA6M 99.81
MAGNUSKI, HANK
2019 BARBARA DR.
PALO ALTO CA 94303

Amateur Satellite Report (USPS 041-850) is published biweekly for $16 (inseparable from annual membership dues of $24) by AMSAT, Post Office Box 27, Washington, DC 20044. Second class postage paid at Silver Spring, MD and additional mailing offices. POSTMASTER: send address changes to *Amateur Satellite Report*, Post Office Box 27, Washington, DC 20044.